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INSTRUCTION MANUAL

MODEL 600

MULTI-PURPOSE ELECTROMETER

AND ACCESSORIES

KEITHLEY INSTRUMENTS, INC.
12415 EUCLID AVENUE CLEVELAND, OHIO

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SECTION I - INTRODUCTION

The Keithley Model 600 Electrometer is an ultra-high impedance voltmeter with full-scale ranges of 0.01, 0.03, 0.10, 0.30, 1.0, 3.0 and 10 volts.

The maximum input resistance is greater than 10^{14} ohms; in addition, the input resistance may be varied in decade steps from one ohm to 10^{11} ohms by means of the shunt resistors built into the instrument. Thus, the 600 is not only appropriate for measurement in high-impedance circuits, but also can be used where a high input impedance would merely introduce unwanted pickup.

The 600 may be used as a direct-reading ammeter from 3 amperes to 10^{-13} ampere full scale. This 14-decade range is covered in overlapping 3x and 10x scales. Two current measuring methods are available to the user of the 600. Normally, current is determined by measuring the voltage drop across a resistor shunted from input to ground. Alternately, on the 10^{-7} to 10^{-13} ampere ranges, negative feedback can be applied to the input of the voltmeter through the current measuring resistor. This largely eliminates the input drop and increases measuring speed, particularly on the more sensitive ranges.

The 600 measures 10K to 10^{12} ohms full scale with a two-terminal input. With a guarded input, its range is extended to 10^{13} ohms. Unlike conventional ohmmeters, information is presented on the linear scales used for current and voltage readings.

As a dc preamplifier, the 600 has gains of 0.1, 0.3, 1, 3, 10, 30 and 100. The continuing stability of the gain is assured by a feedback factor in excess of 100 on any range.

The output is minus 1 volt, open circuit, with an internal resistance of 17K. Thus, the output may be used for driving oscilloscopes or pen recorder amplifiers, or the output may be shunted down to provide 10- or 50-mv outputs for servo-rebalance recorders.

SPECIFICATIONS

Ranges:

(a) Voltage: 0.01, 0.03, 0.1, 0.3, 1, 3, and 10 volts full scale.
(b) Current: 3 amperes to 10^{-13} amperes full scale in 1x and 3x overlapping ranges.
(c) Ohms: 10^{4} ohms to 10^{13} ohms full scale on linear 1x and 3x overlapping ranges.

Accuracy:

(a) Voltage: 2% of full scale on all ranges.
(b) Current: 3% of full scale from 3 amperes to 10^{-10} amperes. 4% of full scale from 3×10^{-11} to 10^{-13} amperes.
(c) Ohms: 4% of full scale from 10^{4} ohms to 10^{9} ohms. 6% of full scale from 3×10^{9} ohms to 10^{14} ohms.

Resistance Standards:

1, 10, 100, 1000, 10^{4}, 10^{5}, 10^{6}, 10^{7}, 10^{8}, ohms 1% accuracy; 10^{9}, 10^{10}, and 10^{11} ohms, 2% accuracy. The 10^{9}, 10^{10} and 10^{11} ohm resistors may be expected to drop in value at about 1% per year.

Input Impedance:

On the VOLTS position, the input impedance is greater than 10^{14} ohms resistive, shunted by approximately 30 micromicrofarads.

Drift:

Less than 2 millivolts per hour after a 30 minute warm-up.

Recorder Output:

Minus one volt for full scale meter deflection, with 17K source impedance.

Amplifier:

Frequency response is DC to 100 cycles on the most sensitive range, rising to 1KC on the least sensitive range. Maximum gain is 100. Noise is less than 3% (peak to peak) of full scale.

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Controls and Terminals: The input connector is Amphenol 83-798. An accessory binding post which plugs into the center of the connector is furnished. A ground binding post is mounted on the panel above the input connector.

Front Panel Controls:

FUNCTION switch, located in the center of the front panel under the meter. This control selects VOLTS, OHMS, or AMPERES. On the AMPERES position, a shunt resistor whose value is the reciprocal of the designated range may be used to decrease the input resistance as well as to measure current.

VOLTS FULL SCALE switch, located at the left under the meter, determines the voltage sensitivity of the dc amplifier, and sets the voltage range when the FUNCTION is set on VOLTS. On OHMS or AMPERES, the setting of this knob multiplied by the OHMS or AMPERES setting gives the full scale meter reading.

ZERO control, located in the center of the front panel directly under the meter, is used to set the meter to zero.

METER switch, at the right under the meter, turns the instrument on, determines meter polarity, and tests the batteries.

ZERO CHECK switch, located at the bottom right, shorts the input terminal through one megohm, while the amplifier input is shorted.

Rear Panel Controls:

OUTPUT connector for external recorders.

NORMAL-FAST. This control is locked in NORMAL position. In FAST position, current measurements are made with feedback around the shunt resistor. On OHMS, the FAST position is used when the INPUT GUARD terminal is used.

INPUT GUARD. With the NORMAL - FAST switch on FAST, the low impedance end of the test sample is returned to this terminal when it is desired to measure the resistance of a guarded sample.

COARSE ZERO. If the amplifier is quite badly unbalanced, the COARSE ZERO switch is used to bring the front panel ZERO control in range.

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Tubes:

Two 5886, two 6418

Cabinet:

6½ wide by 9½ high by 6½ deep. Weight 7 lbs.

Batteries:

Battery	Type	Expected Life
B1, B3	RM42R	700 Hours
B2a, B2b	TR146R	16000 Hours
B4, B5	413	700 Hours
B6, B7	TR146R	Shelf

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SECTION III - OPERATION

A. PREPARING THE INSTRUMENT FOR OPERATION

(1) Set controls as follows:

VOLTS SWITCH: 10 volts.

FUNCTION SWITCH: VOLTS

ZERO CHECK SWITCH: Locked

INPUT TERMINAL: Shield with cap

(2) Turn the METER switch to meter +. The instrument should come to zero in approximately 5 seconds.

(3) Rotate the VOLTS switch toward the high sensitivity end, adjusting ZERO as required. If it is impossible to zero the meter with the front panel ZERO control, use COARSE ZERO control on rear panel to bring the instrument within range of the ZERO control.

(4) Connect leads as required for measurement. If high impedance is involved, the input should be shielded using a coaxial connection or shielded enclosure. The various accessories for the Model 600 may be used.

If the impedance is low (below about 10^{10} ohms) and leads can be kept short, the binding post adapter furnished with the instrument may be used.

The Keithley Model 6101 Shielded Test Probe will suffice for most measurements.

B. MEASURING VOLTAGE

Place FUNCTION switch at VOLTS. Turn VOLTS switch to expected sensitivity and check meter zero. Release ZERO check, and read. If the sensitivity of the instrument is increased, recheck the zero reading.

C. MEASURING CURRENT

(1) NORMAL method (3 amperes to 10^{-13} amperes full scale)

Turn FUNCTION switch to desired AMPERES range. Make sure the switch at the rear of the instrument is on the NORMAL position. Connect current source to the input. Full scale sensitivity is the product of the settings of the FUNCTION switch and OHMS-AMPS MULTIPLIER. Check zero with the ZERO CHECK switch and then read the unknown current. The full scale voltage drop is the setting of the OHMS-AMPS MULTIPLIER.

(2) FAST method (10^{-7} to 10^{-13} amperes full scale)

Proceed as above except with the FAST-NORMAL switch at FAST. The input drop is now negligible and the input circuit time constant is reduced at least 100 times. Observe the following cautions:

(a) Use only the ZERO CHECK switch to check zero. Do not short the input.

(b) The low side of the output is no longer at ground. Therefore, a recorder attached to the output must not be grounded to the Model 600.

(c) Do not use this method for the measurement of capacitor leakage.

D. MEASURING OHMS

(1) NORMAL method (10K to 10^{11} ohms full scale).

Turn FUNCTION switch to desired OHMS range. Make sure that NORMAL-FAST switch is in the NORMAL position.

Connect resistance sample to be measured only after ZERO CHECK switch has been locked. The test voltage at full scale is the setting of the OHMS-AMPS MULTIPLIFER. Before reading OHMS, turn FUNCTION switch to the approximate range of the unknown resistance. By manipulating the OHMS-AMPS MULTIPLIER and the FUNCTION switch, the sample can be tested at a number of test potentials, if desired.

This two terminal method is the simplest and will work quite satisfactorily up to about 10^{11} ohms. At resistances greater than 10^{11} ohms, it is desirable to employ a GUARD connection both to speed up the response of the instrument and to nullify the error of leakage across the electrometer input insulation.

(2) GUARDED method (10^{11} to 10^{13} ohms full scale).

Proceed as with the two terminal method with the exception that the sample is connected between the INPUT terminal and the GUARD terminal on the rear panel. The FAST-NORMAL switch must be set at FAST.

(3) EXTERNAL VOLTAGE methods.

Any external voltage may be used. The unknown is connected between the test potential and the INPUT terminal of the electrometer. The current is then measured, using the NORMAL or FAST method, and the resistance calculated.

Proceed as follows:

(a) Lock the ZERO CHECK Switch.

(b) Connect unknown between INPUT terminal and source of potential. A switch should be connected in the high voltage line so that when the sample is disconnected from the potential, the low impedance end of the sample is grounded.

(c) FAST-NORMAL switch should be at NORMAL.

(d) Apply potential to sample before unlocking ZERO CHECK. Start the FUNCTION switch at low current sensitivities and advance the sensitivity until a reading is obtained.

If the potential applied is at least 100 times the ammeter drop (the setting of the VOLTS FULL SCALE switch), the resistance is equal to:

$$\frac{\text{POTENTIAL APPLIED}}{\text{CURRENT READING}}$$

If the potential applied is not large compared to the ammeter drop, the resistance is equal to:

$$\frac{\text{POTENTIAL APPLIED - INPUT DROP (VOLTS)}}{\text{CURRENT READING}}$$

(e) If it is possible to operate on FAST micro-microammeter, the input drop need not be considered in the calculation.

E. BATTERY CHECK

Turn METER switch to B1, B2, etc. All batteries should read half scale or higher on the meter.

B1, B3, B4, and B5 are tested directly. B2a and B2b are tested in series on position B2. Since the battery drains are nearly identical in B2a and B2b, both should be changed when the series arrangement reads low.

B6 and B7 are not tested because they are operated under virtually shelf-life conditions. They may be replaced yearly as preventive maintenance or may be tested at any time by removing the case and measuring with a voltmeter. They should be replaced if they test less than eight volts.

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F. USING EXTERNAL INDICATORS

The output of the Model 600 may be used to drive servo rebalance recorders as well as high impedance devices such as oscilloscopes and pen drive amplifiers.

(1) For use with servo rebalance recorders:

The output circuit consists of a 16.67K resistor through which 60 microamperes flow for full scale deflection of the panel meter. Shorting the output does not affect the meter reading of the Model 600, but low impedances placed across the output terminals lower the terminal voltage for full scale deflection. Thus, if it is desired that the output voltage for full scale be 10 millivolts, a 168 ohm resistor should be connected across the output terminals. If a full scale of 50 millivolts is required, 878 ohms should be used.

(2) For use with oscilloscopes and pen recorder amplifiers, the output is minus one volt for full scale meter deflection on any range.

The frequency response is dc to 100 cycles on the 10 millivolt range rising to 1 kc on the 10 volt range. The maximum amplitude which can be delivered by the amplifier is approximately 2 volts peak to peak.

G. MISCELLANEOUS APPLICATIONS

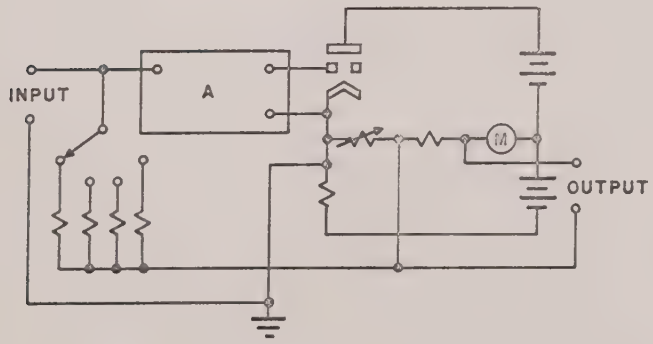


FIGURE 600-1

CURRENT INTEGRATOR:
The Model 600 may be used as an integrator for small currents such as cyclotron and mass spectrometer beam currents, since it is basically an operational amplifier with electrometer input when the FAST-NORMAL switch at the rear is placed in the FAST position.

To integrate current, connect a polystyrene capacitor of suitable value between the GUARD terminal and the input. The FUNCTION switch is set at VOLTS so that there is no resistance placed across the capacity. Then if Fig. 600-1 is consulted, it can be seen that the standard resistor has been replaced by a capacitor and the 600 is now an integrator. The full scale charge on the capacitor in coulombs is simply the product of the capacitor value chosen (in farads) and the setting of the VOLTS

FULL SCALE switch (in volts). If it is desired that a time constant be introduced into the integrating circuit the appropriate shunt resistor may be selected by the function switch.

Practically, it is suggested that the capacitor be enclosed in a grounded can. The connection to the GUARD terminal may be made by a simple unshielded lead. The connection to the input terminal should be made by means of a coaxial connection to one side of a "tee" adapter. The current input is made to the other side of the "tee".

The following procedure is suggested: Depress the ZERO CHECK switch, thus removing the charge from the capacitor and shorting the input. Zero if necessary. Release the ZERO CHECK switch. If the integration is to take place over a long period of time it is suggested that the instrument be used on the one volt range or higher so that zero drift and grid current will not be factors.

CURRENT SOURCE: When measuring ohms, the instrument is designed to supply a constant current to any device placed across its input terminals. The magnitude of the current is equal to the reciprocal of the designation on the OHMS segment of the function switch. Therefore the instrument may be used as a current source for calibration of other instruments if desired.

Depress ZERO CHECK and turn FUNCTION switch to OHMS. The current that is supplied on each range is the reciprocal of the OHMS setting, and is not affected by the setting of the VOLTS FULL SCALE switch. However, for the current to be accurate, the amplifier should be in balance. It will be sufficient to balance the amplifier on the .1 volt range of the VOLTS Switch.

STATIC CHARGE MEASUREMENTS: The instrument is zeroed and the FUNCTION switch placed on VOLTS. The voltage sensitivity is perhaps placed at 3 or 10 volts full scale. The charged object is then brought near the uncovered, unshielded input connector of the 600. Depending on the distance between the charge and the instrument a voltage will be induced on the input terminal and can be read on the panel meter. The instrument zero should be checked frequently since accumulation of charge due to the electrometer tube grid current will cause a slow drift of input voltage.

Connecting a capacitor across the input reduces the drift due to grid current and also the sensitivity to charge. An electrode connected to the INPUT terminal which increases the capacitance between the INPUT terminal and the charged object will increase the sensitivity to charges.

SECTION IV - CIRCUIT DISCUSSION

The basic element of the Model 600 is a highly accurate, stable dc voltmeter with a full scale sensitivity of 10 millivolts and an input impedance greater than 10^{14} ohms shunted by 30 micro-microfarads. Amperes and ohms are measured by the use of resistance standards. The various connections necessary for ampere and ohms measurements will be discussed following the detailed description of the amplifier.

A. VOLTMETER

Refer to DR12014C at the rear of the manual.

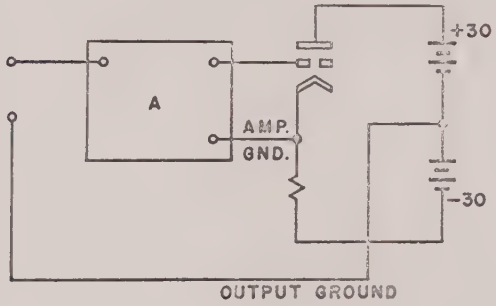


FIGURE 600-2

The amplifier proper consists of V1, V2, and V3. V4 is a cathode follower which drives the amplifier at the same instantaneous potential as the input signal. In other words the neutral or ground terminal of the amplifier is not grounded to the chassis but is attached to the output cathode follower. Fig. 600-2 shows this diagramatically. The amplifier A is driven by the cathode follower.

Input dividers are neither stable nor accurate at high impedance. Consequently, the Model 600 will accept 10 volts without the use of input dividers, preserving the high input impedance and accuracy of the amplifier. Accessory probes are available for extending the voltage range at reduced input resistance and accuracy.

Since the amplifier proper is driven by the cathode follower, the plus and minus 30 volt batteries for the cathode follower are referred to input ground while the battery supplies for the amplifier are referred to amplifier ground which is "floating". In subsequent discussion, reference will be made to the amplifier ground as "floating ground" and to cathode follower ground as "output ground".

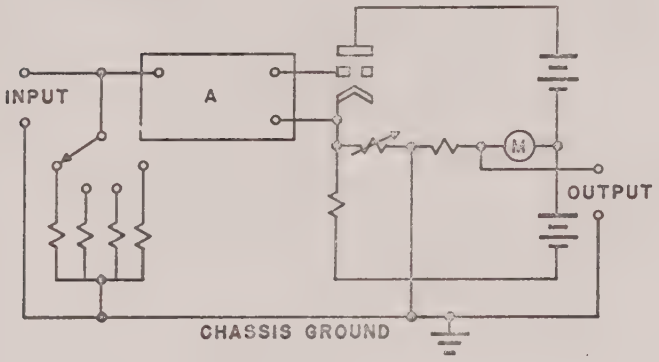
The amplifier input consists of two balanced 5886 electrometer tubes. The filaments are operated in parallel from battery B1. The control grid of V1, the active electrometer tube, is protected by R2, a 10^9 ohm resistor, bypassed for high frequencies by C2. The control grid of V2, the "dummy" tube, is returned through a variable voltage to floating ground. This variable supply is made up from B2a, B2b, R15 (ZERO on the front panel) and R11, R28, R29, R30, R31, R32 on SW-4 (COARSE ZERO on rear panel).

The ZERO controls function by adjusting the dc voltage of the dummy electrometer tube grid.

The voltmeter sensitivity is determined by the resistor placed in series with the meter, R33 through R39. Meter current passing through R42 develops the constant one volt output for any range.

C3 and R6 serve to stabilize the feedback loop against oscillation.

B. AMMETER



Grid current of the input electrometer tube fixes the minimum current that may be measured. The Model 600 grid current will usually be less than 2×10^{-14} amperes. On low current ranges, the grid current will be apparent and may be balanced out with ZERO control or subtracted from the final reading.

FIGURE 600-3

(1) Shunt Resistor Method (NORMAL)

In the normal operating connection as shown in Fig. 600-3, current is measured by placing a resistor across the input terminals and measuring the voltage drop. Currents from 3 amperes to 10^{-13} amperes may be measured by this method since the range switch selects resistors ranging from one ohm to 10^{11} ohms in decade steps. The voltage drop is selected by the VOLTS switch; the setting is the input voltage drop for full-scale meter deflection.

(2) Feedback Method (FAST)

In the voltmeter discussion above, floating ground has been driven by the cathode follower and output ground has been connected to the low impedance side of the input connector. In the FAST connection, shown in Fig. 600-1, the amplifier ground is connected to the low impedance side of the input; the cathode follower ground floats, and negative feedback is applied through the shunt resistor.

In the Model 600, it is possible to use this connection with currents of 0.1 microamperes or less. To change the connection, remove the lock from NORMAL-FAST switch at the bottom of the rear panel and change it to the FAST position. The advantages of this connection are:

(a) The effect of input capacity is largely neutralized, that is, the time constant of the input and cable capacity and the shunt resistor used will be decreased at least 100 times as

compared to the NORMAL connection, corresponding to a 100-fold increase in response speed.

(b) The input drop will be reduced about 100 times.

If Fig. 600-1 is again consulted, it will be seen that this connection converts the 600 into an operational amplifier with a resistor from the output to the input. Therefore, the following cautions apply:

(a) The input cannot be shorted since this will remove the feedback.

(b) The internal impedance of the current source being measured should not be less than about one-tenth of the value of the feedback resistor used for measurement.

(c) This connection should not be used for measuring the leakage current of capacitors since the connection of a capacitor to the input causes the circuit to be transformed into a differentiator with the resultant extreme sensitivity to very small voltage transients. For this measurement the NORMAL should be used.

(d) Do not attempt to use the FAST connection for currents exceeding 0.1 microamperes.

C. OHMMETER

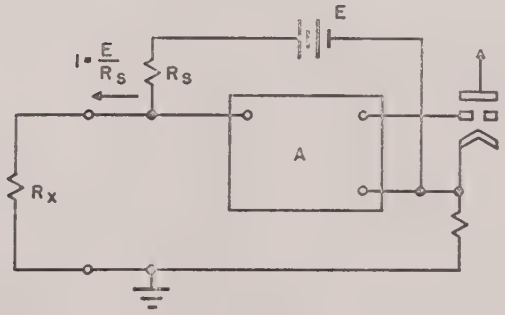


FIGURE 600-4

(1) Two Terminal Method

The Model 600 employs a linear scale to provide a megohmmeter of high accuracy. The linear ohms scale is achieved by supplying a constant current to the sample and measuring the voltage drop across it. The method is shown in Fig. 600-4.

(2) Ohms measurement using GUARD terminal:

There are two disadvantages with the method just outlined:

(a) When measuring resistances greater than 10^{11} ohms, input capacity causes the meter reading to be annoyingly slow.

(b) If it is desired to use large voltages across the sample, this same voltage will appear across the input insulation of the electrometer and the input insulation will contribute error to the reading because of the current also flowing in it.

For these reasons a second connection for measuring ohms is provided.

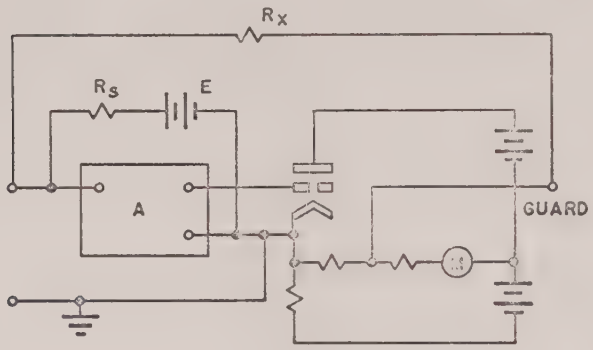


FIGURE 600-5

The switch at the rear of the instrument is moved from NORMAL to FAST and the low impedance end of the resistance sample is connected to the GUARD terminal. Fig. 600-5 shows the arrangement. Now, as with measuring amperes with the FAST method, the amplifier ground is attached to the input ground and the cathode-follower ground is floating. The result is that feedback is applied through the unknown resistance to reduce the slowing effect of instrument input capacity. Also, since the potential across the input terminal is small, the leakage error is reduced.

(3) Use of External Voltage Supply

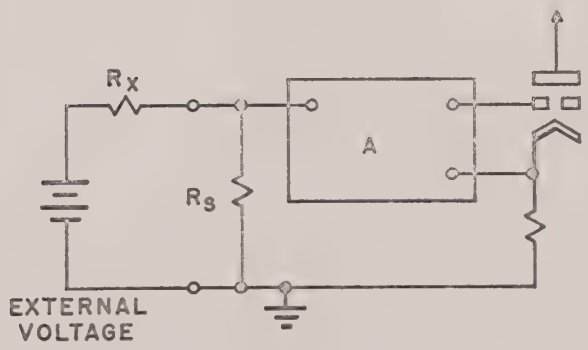


FIGURE 600-6

With the constant current method of measuring resistance, the voltage across the unknown may not be arbitrarily selected, and the time of measuring capacitor leakage tends to be long, since constant-current charging is slower than the exponential charge available with an RC circuit.

Due to these facts, it may be desirable to use an external voltage supply and measure the leakage current on the AMPERES scale (NORMAL operation).

The unknown is connected between the input terminal of the electrometer and the source of voltage. This is shown in Fig. 600-6. If the applied voltage is large compared to the voltage drop across the electrometer (so that the voltage across the sample is substantially the applied voltage) the resistance is simply equal to the voltage applied divided by the current measured. If the voltage drop is an appreciable fraction of the applied voltage, the resistance equals the voltage applied minus the input

drop divided by the current measured. It will be rarely necessary to correct for the input drop of the electrometer due to the excellent voltage sensitivity of the Model 600.

It is advisable to use the NORMAL micro-microammeter connection for the measurement of leakage resistance of capacitors in this manner, since instability is likely to occur using the FAST connection. However, in cases where the capacity shunted across the sample is small, it will be possible to realize a considerable increase in speed of response by utilizing the FAST connection.

Some precautions are recommended when testing capacitors. Be sure that capacitors have discharged before removing from test circuit. With the ZERO CHECK switch depressed, the input is shorted to ground through 1 megohm, providing a discharge path for the capacitor. The reading time may be shortened if the capacitor is allowed to charge through a low impedance position on the AMPERES switch before the appropriate measuring resistor is inserted in the circuit.

It should be further noted that capacitor measurement is likely to be a slow process in any case due to the fact that it may take considerable time for the molecular orientation of the dielectric to take place at the testing potential. It may take minutes or even hours in some cases to achieve a stable reading.

SECTION V - ACCESSORIES

MODEL 6101 ACCESSORY PROBE:

The Model 6101 probe consists of an input connector, 3 feet of low noise cable and a shielded probe head. Its purpose is to allow convenient connection to the electrometer input.

MODEL 6102 - 10:1 DIVIDER PROBE:

The Model 6102 divider probe is intended for general purpose measurements where an extension of the upper voltage range of the 600 is desired. The division ratio is 10:1 correct to 1% and the probe input resistance is 10^{10} ohms. The probe is supplied with a mating connector and 3 feet of cable.

MODEL 6103 - 1000:1 DIVIDER PROBE:

The Model 6103 probe is intended for very high voltage measurements at high impedance. The division ratio is 1000:1 correct to 3% and the probe input resistance is 10^{12} ohms. The probe is supplied with a mating connector and 3 feet of cable.

MODEL 6104 TEST ADAPTER:

The Model 6104 Test Adapter is intended for use in making measurements wherein complete shielding of the component under test is required. External terminals are provided for either grounded tests, or a test requiring an external voltage source.

SECTION VI - MAINTENANCE

No periodic maintenance is required other than checking the batteries as provided for by the front panel control. The method of performing these checks is outlined in Section III-E.

The calibration of the voltmeter is set by R40 located on the horizontal chassis carrying B1, B3, B4 and B5. This is set at the factory and should not require adjustment. If recalibration is performed, an accurate voltage source should be used.

A. Trouble Shooting

The circuit is completely described in Section IV. Study of that section will facilitate any trouble shooting.

The most usual trouble encountered is that on the most sensitive voltage range, with the input shorted, it is not possible to bring the meter pointer to zero. However before assuming that the instrument is at fault make sure that resetting the COARSE ZERO control at the rear of the instrument will not bring the instrument back into balance. If this does not work remove the instrument case to gain access to all circuitry. Follow this procedure:

Short floating ground to output ground to remove the negative feedback. This is most conveniently accomplished by shorting the two ends of the FAST-NORMAL switch on the rear panel. In this condition the instrument will become very sensitive and, in operating the zero control, the meter will be very difficult to hold on scale. However, the indication that the circuit is operating satisfactorily is that it is possible to swing the voltage through the correct operating point as indicated on the voltage-resistance diagram.

Now with the VOLTS switch at .01 volts, proceed to check the operating points of the tube electrodes.

Regardless of the condition of the amplifier balance, the filament or cathode, and screen potentials should be reasonably close to the values on the circuit diagram. The plate and grid potentials will depend on the setting of the ZERO control. However if it is possible to swing the voltage through the correct value it may be assumed that the stage is working. Proceed in this manner until the point is found where the voltage cannot be swung through the value marked on the diagram. At this point it will be relatively easy to find the fault. First check the tube involved and then check the components.

Miscellaneous troubles:

Trouble	Cause	Remedy
Excessive grid current	Defective electrometer tube	Replace V1 and V2 with matched set
Excessive drift	Battery failing	Replace battery
Excessive microphonics	Defective electrometer tube	Replace V1 and V2 with matched set
Instrument does not zero.	See section above	See section above

The proper method of inserting electrometer tubes is shown in the voltage-resistance diagram. When inserting do not touch the glass base, where the leads emerge, with the fingers.

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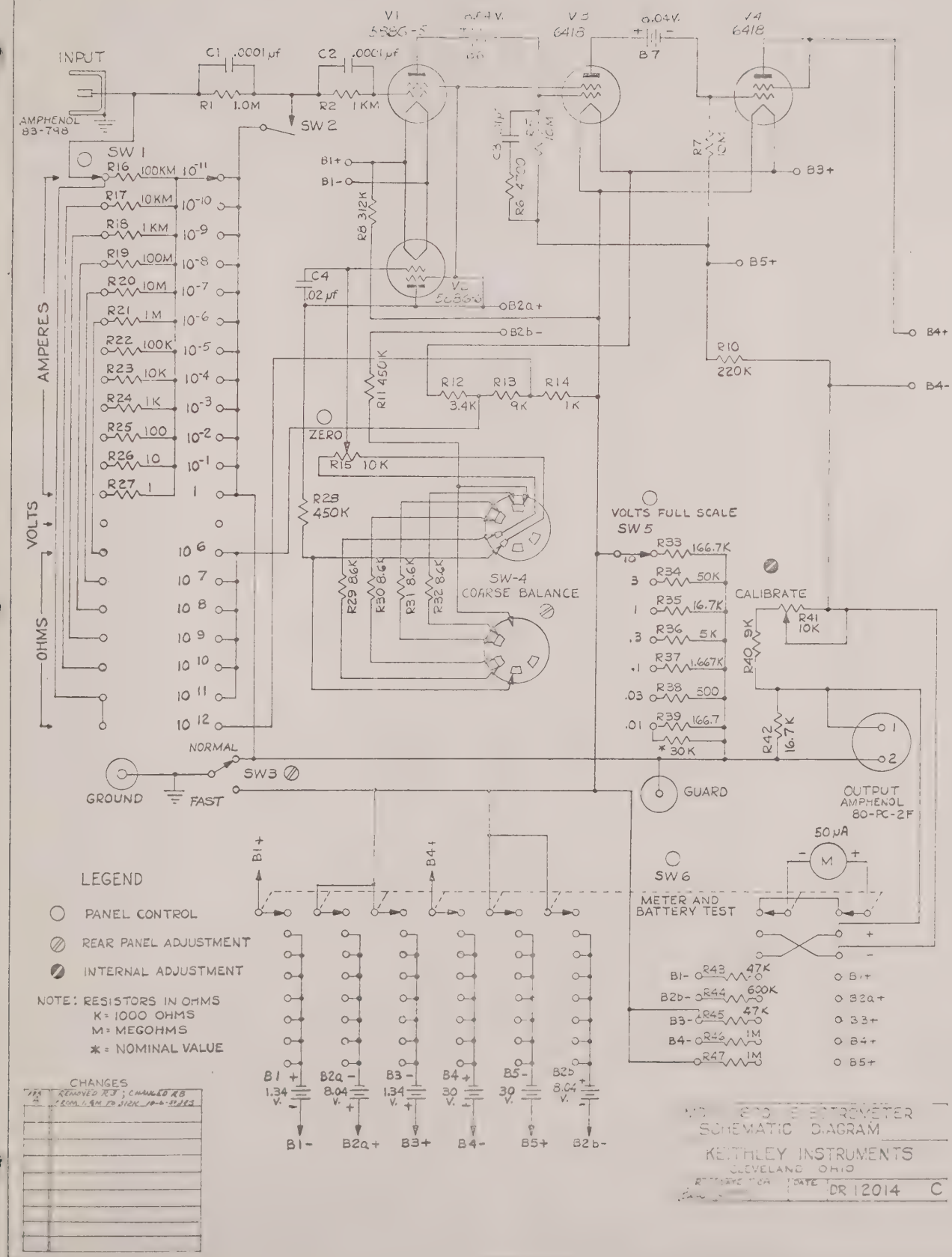
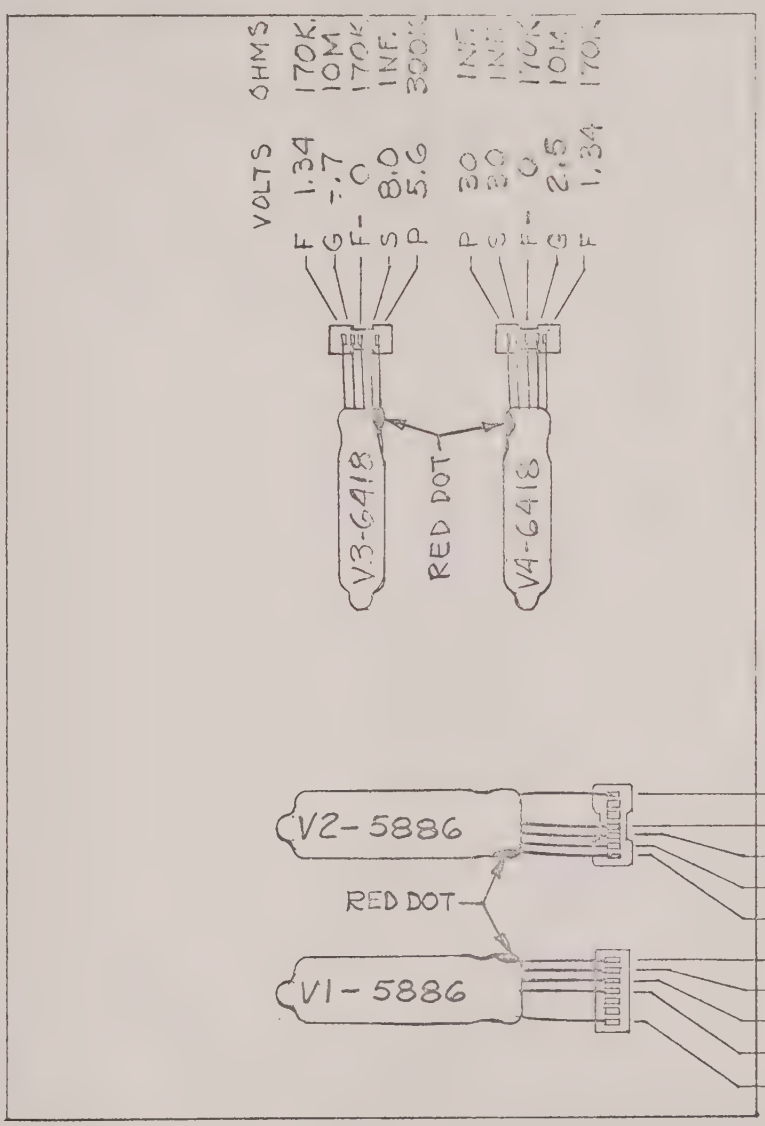

INPUT
AMPHENOL 83-7R8
SW 1
SW 2
C1 .0001 µf
C2 .0001 µf
R1 1.0M
R2 1 KM
V1 5886-5
V3 6418
V4 6418
0.04V.
B7
C3 .01µf
R6 4.7M
R7 10M
R8 312K
C4 .02 µf
V2 5886
B1+
B1-
B2a+
B2b-
B3+
B5+
B4+
B4-
R10 220K
R11 450K
R12 3.4K
R13 9K
R14 1K
R15 10K
R28 450K
ZERO
AMPERES
VOLTS
OHMS
R16 100KM 10-11
R17 10KM 10-10
R18 1 KM 10-9
R19 100M 10-8
R20 10M 10-7
R21 1M 10-6
R22 100K 10-5
R23 10K 10-4
R24 1K 10-3
R25 100 10-2
R26 10 10-1
R27 1 1
10 6
10 7
10 8
10 9
10 10
10 11
10 12
R29 8.6K
R30 8.6K
R31 8.6K
R32 8.6K
SW-4 COARSE BALANCE
VOLTS FULL SCALE SW 5
10
3
1
.3
.1
.03
.01
R33 166.7K
R34 50K
R35 16.7K
R36 5K
R37 1.667K
R38 500
R39 166.7
* 30K
CALIBRATE
R41 10K
R40 9K
R42 16.7K
1
2
NORMAL
SW3
GROUND
FAST
GUARD
OUTPUT AMPHENOL 80-PC-2F
50µA
M
SW 6
METER AND BATTERY TEST
B1+
B4+
B1- R43 47K
B2b- R44 620K
B3- R45 47K
B4- R46 1M
R47 1M
B1+
B2a+
B3+
B4+
B5+
LEGEND
PANEL CONTROL
REAR PANEL ADJUSTMENT
INTERNAL ADJUSTMENT
NOTE: RESISTORS IN OHMS
K = 1000 OHMS
M = MEGOHMS
* = NOMINAL VALUE
B1 + 1.34 V. -
B2a - 8.04 V. +
B3 - 1.34 V. +
B4 + 30 V. -
B5 - 30 V. -
B2b + 8.04 V. -
B1-
B2a+
B3+
B4-
B5+
B2b-
CHANGES
REMOVED R3 ; CHANGED R8 FROM 1.4M TO 312K 10-6-61 ECO
ELECTROMETER
SCHEMATIC DIAGRAM
KEITHLEY INSTRUMENTS
CLEVELAND OHIO
DR 12014 C

DR 12124 -A

CHANGES



	VOLTS	OHMS
G	0	INF.
F-	2.7	INF.
F	3.8	INF.
S	8.0	INF.
P	8.0	INF.
P	8.0	300K
S	8.0	INF.
F	3.8	INF.
F-	2.7	INF.
G	0	INF.

THE ABOVE VOLTAGE AND RESISTANCE READINGS WERE TAKEN WITH CONTROLS SET AS FOLLOWS;

VOLT SWITCH ON 10
METER SWITCH ON METER +
RANGE SWITCH ON VOLTS
ZERO CHECK LOCKED
OUTPUT AT ZERO
FAST-NORMAL SWITCH IN NORMAL POSITION

RESISTANCES ARE APPROXIMATE. READINGS TAKEN WITH VTVM TO GROUND.

MODEL 600 ELECTROMETER
VOLTAGE-RESISTANCE DIAGRAM

KEITHLEY INSTRUMENTS
CLEVELAND, OHIO

DR	DATE	CH	DATE	DR 12124 -A
Paul	8-11-58			

REPLACEABLE PARTS LIST - MODEL 600

Circuit Desig.	Description	Part No.
B1	Battery, mercury, 1.34v, 14000 MAH	BA-10
B2a	Battery, mercury, 8.04v, 400 MAH	BA-9
B2b	Same as B2a	
B3	Same as B1	
B4	Battery, layer dry cell, 30v	BA-5
B5	Same B4	
B6	Same as B2a	
B7	Same as B2a	
C1	Capacitor, ceramic disc, 100 mmf, 600v	C22-100
C2	Same as C1	
C3	Capacitor, ceramic disc, .01 mfd, 600v	C22-.01
C4	Capacitor, ceramic disc, .02 mfd, 600v	C22-.02
M	Meter, 50 microampere, dial 430-1326	ME-12
R1	Resistor, composition, $\frac{1}{2}$w, 10%, 1 meg	R1-1M
R2	Resistor, composition, $\frac{1}{2}$w, 20%, 10^9 ohms	R37-10^9
R5	Resistor, deposited carbon, 1w, 1%, 10 meg	R13-10M
R6	Resistor, composition, $\frac{1}{2}$w, 10%, 4700	R1-4700
R7	Same as R5	
R8	Resistor, deposited carbon, $\frac{1}{2}$w, 1%, 312K	R12-312K
R10	Resistor, deposited carbon, $\frac{1}{2}$w, 1%, 220K	R12-220K
R11	Resistor, deposited carbon, $\frac{1}{2}$w, 1%, 450K	R12-450K
R12	Resistor, deposited carbon, $\frac{1}{2}$w, 1%, 3400	R12-3400
R13	Resistor, deposited carbon, $\frac{1}{2}$w, 1%, 9K	R12-9K
R14	Resistor, deposited carbon, $\frac{1}{2}$w, 1%, 1K	R12-1K
R15	Potentiometer, 10 turn, 5%, 10K	RP[illegible]-10K
R16	Resistor, wirewound, 10w, 1%, 1 ohm	R34-1
R17	Resistor, wirewound, 10w, 1%, 10 ohm	R34-10
R18	Resistor, wirewound, 10w, 1%, 100 ohm	R34-100
R19	Resistor, deposited carbon, 1w, 1%, 1K	R13-1K
R20	Resistor, deposited carbon, $\frac{1}{2}$w, 1%, 10K	R12-10K
R21	Resistor, deposited carbon, $\frac{1}{2}$w, 1%, 100K	R12-100K
R22	Resistor, deposited carbon, $\frac{1}{2}$w, 1%, 1M	R12-1M
R23	Same as R5	
R24	Resistor, deposited carbon, 2w, 1%, 100M	R14-100M
R25	Resistor, glass, 2%, 10^9 ohms	R20-10^9
R26	Resistor, glass, 2%, 10^{10} ohms	R20-10^{10}
R27	Resistor, glass, 2%, 10^{11} ohms	R20-10^{11}
R28	Same as R11	
R29	Resistor, deposited carbon, $\frac{1}{2}$w, 1%, 8.6K	R12-8.6K
R30	Same as R29	

Circuit Desig.	Description	Part No.
R31	Same as R29	
R32	Same as R29	
R33	Resistor, deposited carbon, ½w, 1%, 166.7K	R12-166.7K
R34	Resistor, deposited carbon, ½w, 1%, 50K	R12-50K
R35	Resistor, deposited carbon, ½w, 1%, 16.7K	R12-16.7K
R36	Resistor, deposited carbon, ½w, 1%, 5K	R12-5K
R37	Resistor, deposited carbon, ½w, 1%, 1.667K	R12-1.667K
R38	Resistor, deposited carbon, ½w, 1%, 500	R12-500
R39	Resistor, deposited carbon, ½w, 1%, 166.7	R12-166.7
R40	Same as R13	
R41	Potentiometer, wirewound, 2w, 10%	RP9-1
R42	Same as R35	
R43	Resistor, deposited carbon, ½w, 1%, 47K	R12-47K
R44	Resistor, deposited carbon, ½w, 1%, 600K	R12-600K
R45	Same as R43	
R46	Same as R22	
R47	Same as R22	
SW1	Switch, special 2 pole, 20 position	
SW2	Switch, push button, special normally open	
SW3	Switch, slide, DPDT	SW45
SW4	Switch, rotary, 2 pole, 5 position	SW51
SW5	Switch, rotary, 1 pole, 7 position	SW47
SW6	Switch, rotary, 8 pole, 8 position	SW52
V1	Tubes, matched pair, type 5886	EV 5886-5
V2		EV 5886-6
V3	Tube, type 6418	EV 6418
V4	Same as V3	

WARRANTY

We warrant each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace any instrument or part thereof, except tubes, transistors, fuses, and batteries, which, within a year after shipment to the original buyer, proves defective on examination.

DAMAGE IN SHIPMENT

Be sure to include the instrument model number and serial number in all communications.

If the instrument is damaged when received, or fails to operate properly, a claim should be filed with the carrier. Upon receipt of the claim agent's report, we will inform you regarding repair or replacement.

REPAIRS

When returning an instrument for repair or recalibration, it should be securely packed against shipping damage and sent to the factory, freight prepaid. A brief letter describing the difficulty should accompany the instrument.

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